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ART. XLI. — *Two New Ceratopsia from the Laramie of Converse County, Wyoming;* by J. B. HATCHER. (With Plates XII, XIII.)

[From a Monograph on the Ceratopsia by J. B. Hatcher. Published by permission of the Director of the U. S. Geological Survey.]

Editorial note.—In the course of his extensive study of the Laramie Ceratopsia contained in the U. S. National Museum and in that of Yale University, Mr. Hatcher discovered two forms which were new to science. These he described in the above mentioned monograph, giving to the first, an undoubted Triceratops, a new specific name, while for the second specimen, which represents a new genus as well as species, no name was suggested by the author. The duty of naming this form devolves therefore upon the editor. The generic name *Diceratops* is suggested by the lack of a nasal horn, while the specific name *hatcheri* will serve to commemorate Mr. Hatcher's work in connection with this remarkable type.

In view of the recent discoveries among these most interesting forms, it has been deemed advisable to publish these descriptions at the present time without waiting for the publication of the monograph.—RICHARD S. LULL.

Triceratops brevicornus sp. nov.

Plate XII, Figures 1 and 2.

Type No. 1834, Yale Museum.

Char. Specific: Supraorbital horn cores short and stout, not much compressed, nearly circular in cross-section. Nasal horn core short and stout with the anterior border vertical instead of being directed upward and forward at an angle of 30 degrees. Vertical and longitudinal diameters of lateral temporal foramen nearly equal. Orbit irregularly elliptical in outline with the longer axis running from above downward and forward. Postfrontal fontanelle open even in old individuals.

The type, No. 1834, Yale Museum, of the present species consists of a nearly perfect skull with lower jaw and a com-

plete series of presacral vertebræ, together with a number of ribs more or less complete, and portions of the pelvis, including a portion of the right ilium and a nearly complete pubis. The vertebral series lay in position with the vertebræ interlocked by their zygapophyses from the axis to the last dorsal, though portions of some of the vertebræ had weathered away when found. Behind the posterior dorsal, impressions of the centra of the first two sacrals were preserved in the hard sandstone in which the skeleton was imbedded.

Locality.—The skeleton was discovered by Mr. W. H. Utterback, and the exact locality was some three miles above the mouth of Lightning Creek and about one and a half miles south of that stream, in Converse County, Wyoming. The horizon was near the summit of the Laramie, and the specimen was collected by the present writer assisted by Messrs. W. H. Utterback, A. L. Sullins, and T. A. Bostwick. When discovered the skeleton lay imbedded in a hard sandstone concretion and was much shattered and weathered about the pelvic region. None of the limb bones and no part of the tail were recovered.

The Skull.

The extremely rugose nature of the skull together with the closed condition of the sutures, many of which are almost or entirely obliterated, make it certain that the type of the present species pertained to an old individual.

The Cranium.—The chief distinctive features of the cranium are as follows: The supraorbital horn cores are unusually short and stout, especially at the base. They are less compressed and more nearly circular in cross-section than in most other species. The nasal horn is short and very stout with the antero-posterior diameter much exceeding the transverse. Its anterior border is directed upward in a line perpendicular with the longer axis of the skull instead of forward and upward at an angle of about thirty degrees to that axis as in the type of *T. prorsus*. The lachrymal foramen, as in *T. serratus*, lies between the maxillary and the nasal, but in the present species its anterior half is entirely enclosed by the maxillary, that bone sending upward a short process alongside the premaxillary process and forming the anterior one-half of the superior border of the foramen. The orbit is elliptical in outline with the longer diameter inclined backward from the perpendicular at an angle of about ten degrees. The lateral temporal fossa is triangular in outline, its respective borders describing nearly an equilateral triangle, the fore and aft diameter only slightly exceeding the vertical. The rostral bone is heavy and very deeply excavated beneath. The epijugal is rather

acutely pointed and regularly triangular in cross-section. The infratemporal arch, as in *T. serratus*, is formed by the quadrate with overlapping processes from the jugal and squamosal, that from the latter element occupying a slightly more elevated position in the type of the present species than in that of *T. serratus*. The exoccipital process extends distally beyond the quadrate and projects as a small angular process. There are six exoccipitals, borne wholly on the squamosal, and at least three more between the last of these and the single median one situated at the median parietal region. Though the frill is not sufficiently perfect in this region to determine the number of epoccipitals with accuracy, there cannot be fewer than nineteen. The postfrontal fontanelle is large and circular in outline. The median longitudinal crest of the parietals is well defined and bears the usual rugosities. Near the apex the right horn core has been worn into a peculiar form by the action of wind, sand and water while it protruded from the sandstone concretion in which it was found prior to its discovery. The palatial view shows no characters essentially different from those of other species of this genus. In the region of the supraoccipitals and parietals the sutures are so obliterated by age and obscured by distortion and crushing that it is quite impossible to determine their nature.

The Lower Jaw.—The lower jaws with the predentary were in position and in a splendid state of preservation. The predentary is rather longer than is common. On the superior surface of the mandibular fossa near the anterior end two large foramina pierce the wall and pass upward toward the dental chamber. The splenial is very broad posteriorly and entirely encloses the mandibular fossa, except at the opening of the internal mandibular foramen. The coronoid process is low and stout and superiorly it is produced forward into a broad and somewhat decurved projection. At its greatest expansion the superior border of the splenial covers over for a short distance the series of dental foramina on the inner side of the dentary. The principal characters of the skull are well shown in Plate XII, figures 1 and 2.

The Vertebræ.—The vertebræ will be fully described in that portion of the monograph relating to the osteology of the genus *Triceratops*.

Principal Measurements of Type of T. brevicornus (*No. 1834, Y. M.*).

Greatest length of skull	1652^{mm}
Greatest breadth of frill	1120
Expanse of jugal	600

Expanse of frontal region at anterior border of orbits	357mm
Greatest diameter of orbit	168
Least " " "	120
Fore and aft diameter of lateral temporal fossa	105
Vertical " " " " "	85
Distance from posterior border of orbit to posterior border of frill	840
Thickness of postfrontal behind orbit	130
Least antero-posterior diameter of horn core immediately above orbit	175
Antero-posterior diameter of horn core, six inches above orbit	117
Transverse diameter of horn core immediately above orbit	140
Transverse diameter of horn core, six inches above orbit	97
Greatest length of squamosal	870
" breadth of "	433
Length of parietals along median line	712
Distance between squamosal sutures at posterior border of frill	874
Distance between squamosal sutures at junction with postfrontals	330
Distance from anterior border of orbit to posterior border of nasal opening	228
Distance between orbit and lateral temporal foramen	142
Distance between lateral and supra-temporal foramina	285
Distance from lateral temporal foramen to posterior border of squamosal	705
Distance from occipital condyle to posterior margin of crest	650
Distance from occipital condyle to interior border of rostral	975
Distance from posterior border of anterior nares to anterior border of rostral	525
Distance from postfrontal foramen to extremity of nasal horn	750
Greatest expanse of exoccipital processes	550
Distance from inferior border of orbit to bottom of jugal	343
Diameter of occipital condyle	88
Distance from mid-frontal region to apex of supraorbital horn	500
Length of splenial	503
" " predentary	255
Greatest breadth of predentary	142
Combined length of dentary and predentary	681
" " " " " articular	620
Total length of presacral vertebral series	2290
" " " dorsal series	1490

Diceratops hatcheri Lull, gen. et sp. nov.

Plate XIII, Figures 3 and 4.

Mr. Hatcher's description is as follows:

"*Char. Generic:* Nasal horn core absent. Squamosal bones pierced by large fenestræ, while smaller ones penetrate the parietals. The inferior border of the squamosal lacks a quadrate notch.

Type No. 2412, U. S. National Museum.

"*Char. Specific:* Supraorbital horn cores short, robust, and nearly circular in cross-section at base, erect and but slightly curved. Orbits project in front of the horns, the frontal region lying between the horns being concave. Exoccipital processes slender and widely expanded.

"*The type*, No. 2412, of the U. S. National Museum, consists of a skull without the lower jaw. The posterior portion of the frill is somewhat weathered but the specimen appears to have suffered comparatively little from crushing.

"*Locality:* The specimen was found in a hard sandstone concretion about three miles southwest of the mouth of Lightning Creek, Converse County, Wyoming. When found the concretion in which the shell was imbedded had entirely weathered out of the surrounding sandstone and stood at an altitude of five or six feet above the ground, firmly attached beneath to another concretion. The skull stood on its nose with the frill pointing upward.

"*The Skull:* The chief distinctive features of the skull are as follows: The supraorbital horn cores are comparatively short, robust, and nearly circular in cross-section at the base instead of compressed, as in most other species. They rise more directly upward than in other species and are only slightly curved. The orbits also occupy a position more anterior than that seen in other species; the anterior borders of the horn cores rise from about the middle of the superior borders of the orbits so that the orbits project well in front of the horns. The frontal region between the orbits is concave. The exoccipital processes are rather slender and widely expanded.

"The nasals terminate anteriorly in a rounded rugosity not developed into anything approaching a nasal horn and resembling that of the type of *Triceratops obtusus*. The rostral bone is small and firmly coössified with the premaxillaries. The latter are elongate but not deep. The maxillaries are massive and the lachrymal foramen is elongate and below and considerably forward of the orbit. The jugal is broad distally and firmly coössified with the epijugal. The lateral temporal fossa is nearly as deep vertically as longitudinally. The squa-

mosal is elongate, and just posterior to the quadrate groove it is pierced by a large fenestra. The antero-inferior angle is little produced and there is no quadrate notch, the inferior border in this region describing widely an open concavity. The parietals are broad and thin and, on either side of the median line about 235^{mm} in front of the posterior border, there is an elongated fenestra with a longitudinal diameter of 150^{mm} and a greatest transverse diameter of 52^{mm}. This fenestra is completely enclosed on the right side, but on the left the parietal is injured in this region. In the drawings it has been restored from the right side. The supra-temporal fossa is elongate. There is a single median postfrontal fontanelle as in *Triceratops*, but posteriorly this gives origin to two deep channels, one on either side. These run backward along the surface of the parietal and terminate in two small circular fontanelles, conditions very similar to those which obtain in *Torosaurus*.

Measurements of the type.

"Distance from anterior end of rostral to posterior of squamosal	1990^{mm}
Distance from anterior end of rostral to anterior of orbits	845
" " inferior border of orbit to lower end of jugal	363
" " posterior border of nasal opening to extremity of beak	614
Distance from posterior border of orbit to posterior surface of horn core	175
Distance between anterior borders of orbits	340
Circumference of supraorbital horn cores at base	610
" " " " mm. above orbit	340
Vertical diameter of orbits	165
Antero-posterior diameter of orbits	125"

[*Note.*—This genus is most nearly allied to *Triceratops* and is distinguished therefrom mainly by the much smaller rostral bone; by the absence of a nasal horn, which in all species save *T. obtusus* is fairly well developed; by the very erect, short, robust, supraorbital horn cores which seem to take their origin much further back with relation to the orbit; by the concavity of the frontal region between the orbits and by the peculiar form of the postfrontal fontanelle. The general proportions of the skull resemble *Triceratops* rather than the contemporary genus *Torosaurus*, in which the great frill so preponderates over the comparatively abbreviated facial region. The parietals resemble those of *Triceratops* except for the presence of the small fenestræ on either side of the median line.

The squamosals differ from those of *Triceratops* in the conformation of the lower border, which lacks the quadrate notch, and in the presence of the unique fenestræ.

Aside from the general proportions of the skull, *Diceratops* and *Torosaurus* differ in the presence in the former of separately ossified epoccipital bones around the margin of the frill. These ossicles are apparently entirely lacking in *Torosaurus*. The two genera agree in the possession of parietal fenestræ though these are evidently not homogenous. They also agree in the form of the postfrontal fontanelle.

While I believe *Diceratops* to be a valid genus, I am not inclined to lay the stress upon the parietal and squamosal fenestræ which Hatcher does, as they may possibly be pathologic. Those of the squamosal bones, which are found in no other form among Ceratopsia, are not of the same size, while only one is known in the parietals for the sufficient reason that the bone is broken away on the left side where the fenestra would come if present, and it is quite possible that it may never have existed.

There is preserved in the Museum at Yale University a *Claosaurus* scapula with a clean cut foramen through it with perfectly healed edges. This foramen is not present in the other scapula from the same individual and Professor Marsh used to say that the perforation was caused by a *Triceratops* horn. This certainly seems suggestive of the manner in which the *Diceratops* fenestræ may have arisen.

RICHARD S. LULL.

Amherst, Mass.]

DESCRIPTION OF PLATES.

PLATE XII.

Skull of the type specimen of *Triceratops brevicornus* Hatcher. No. 1834, Yale University Museum. One-sixteenth natural size.

FIGURE 1.—Lateral view. *ang*, angular; *art*, articular; *cp*, coronoid process; *D*, dentary; *ep*, epoccipital; *ju*, jugal; *lf*, lachrymal foramen; *mx*, maxillary; *no*, nasal opening; *nh*, nasal horn core; *o*, orbit; *pa*, parietal; *pd*, predentary; *pmx*, premaxillary; *qu*, quadrate; *r*, rostral bone; *sang*, surangular; *sq*, squamosal; *soh*, supraorbital horn core.

FIGURE 2.—Palatal view. *dc*, dental channel; *exo*, exoccipital; *ju*, jugal; *mx*, maxillary; *pa*, parietal; *pal*, palatine; *pmx*, premaxillary; *pt*, pterygoid; *qu*, quadrate; *r*, rostral bone; *sq*, squamosal; *BO*, basioccipital; *C*, occipital condyle.

PLATE XIII.

Type skull of *Diceratops hatcheri* Lull. No. 2412, U. S. National Museum. One-sixteenth natural size.

FIGURE 1.—Lateral view. *ep*, epoccipital; *lf*, lachrymal foramen; *mt*, maxillary teeth; *mx*, maxillary; *n*, nasal; *NO*, nasal opening; *o*, orbit; *pa*, parietal; *pmx*, premaxillary; *qu*, quadrate; *r*, rostral bone; *SF*, squamosal fenestra; *soh*, supraorbital horn core.

FIGURE 2.—Dorsal view. *ep*, epoccipital; *lf*, lachrymal foramen; *n*, nasal opening; *o*, orbit; *pa*, parietal; *paf*, parietal fenestra; *pff*, postfrontal fontanelle; *r*, rostral bone; *SF*, squamosal fenestra; *sq*, squamosal; *soh*, supraorbital horn core.

Art. XLII—*Restoration of the Horned Dinosaur Diceratops;* by Richard S. Lull. (With Plate XIV.)

The new genus and species described by Hatcher in the preceding article represents perhaps the most bizarre and grotesque form among all the race of horned dinosaurs, and the author has attempted an interpretation for the purpose of emphasizing the features wherein this animal differed from any of its allies.

Diceratops comes from the Laramie of Converse County, Wyoming, and while contemporaneous with Triceratops and Torosaurus it is probably as late in geological time as any of the species of either genus, and may be said to represent the culmination of at least one phylum of the Ceratopsia. Diceratops differs from Torosaurus in the proportions of the skull, for in the latter genus the frill is relatively huge as contrasted with the abbreviated facial region. In this Diceratops and Triceratops agree, and it is quite evident that there is a genetic relationship between these genera, while Torosaurus represents a totally distinct phylum.

Perhaps the most notable point of distinction between Triceratops and Diceratops is the presence of a fairly well developed nasal horn in the former while in the latter genus it is lacking, a feature which in the author's mind represents the culmination of specialization.

The earliest known Ceratopsia are the Judith River types, characterized by an incomplete frill, by rudimentary horns above the eyes, and by a very well developed, generally erect or backwardly curved nasal horn.

The supraorbital horns are progressive structures while the nasal horn is retrogressive, and during the lapse of time between the Judith River and Laramie periods, when the marine Bearpaw shales and Fox Hills sandstones were laid down, the Ceratopsia underwent a remarkable though unrecorded evolution, for when they again come into view in the Laramie the armament is reversed, in that the great temporal horns are by far the larger and more efficient weapons, and the diminishing nasal horn, while supplementing the others in the various species of Triceratops and Torosaurus, is vestigial in the form under discussion.

This change of armament was necessarily accompanied by a change in the method of attack, for while the Judith River types probably used the one horn much as the rhinoceros does, with an upward thrust, Triceratops seems to have charged with lowered head, the small forwardly directed nasal and the larger

supraorbital horns meeting the enemy at the same moment of impact. The frill now becomes of greater protective value instead of affording leverage merely for the muscles of the neck.

Diceratops exhibits the extreme of development of this style of warfare, for the supraorbital horns are the sole aggressive weapons while the widely expanded frill served admirably to withstand the shock of the adversary's horns. We have here a precise analogy with the knight of old tilting with his spear and shield.

The skull of Diceratops shows the horns to be very erect, much more so than in Triceratops, so that the head would have to be carried much lower in charging than in the latter genus and the horns through relatively short are extremely powerful. I have indicated a callosity, the last vestige of a horn, over the nasals, for they still remain very highly arched and evidently bore some of the impact of the adversary's blow. The eyes were set in deep thick-rimmed sockets which look directly outward, evidently limiting the forward range of vision, but affording ample protection to these highly necessary organs.

If one will turn to Hatcher's figure of the Diceratops skull (Plate XIII, figures 1 and 2), he will notice in the frill several apertures which Hatcher has called "fenestræ." Two of these are through the squamosal portion of the frill, one on either side, and one through the parietal.* They are irregular in size and in position, and while the Judith River types and Torosaurus among the Laramie forms have *parietal* fenestræ, they are large and symmetrical, and there is no instance of *squamosal* fenestræ in any known genus of Ceratopsia. If the author's conception of the final function of the frill is correct, there would be no reason for the development of apertures through it, which would only tend to weaken it and mar its usefulness. It seems vastly more probable that these are "old dints of deep wounds" received in combat. None of them, not even the great one on the left, were necessarily fatal, as they all seem to be through the free portion of the frill, and, while the bone was destroyed, the horny or leathery integument may have grown again over the gap as indicated in the model. The edge of the apertures are healed, showing that the animal lived for some time after the injuries were received.

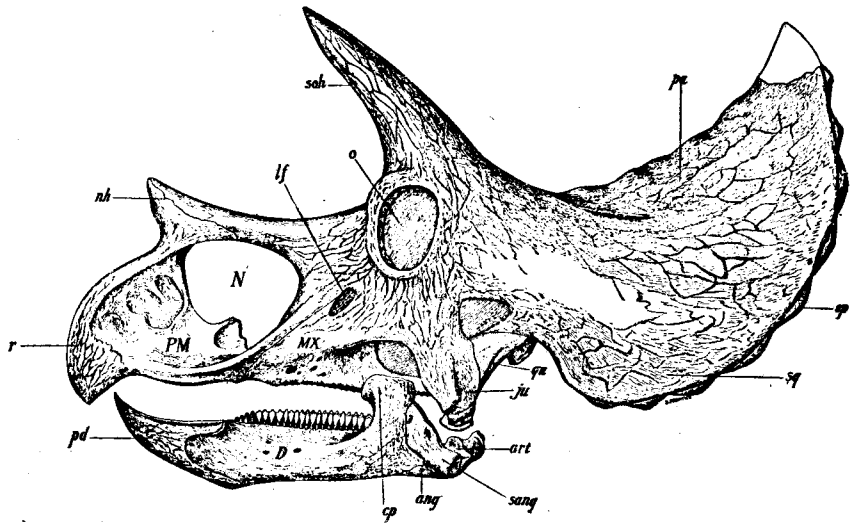
I have represented the gape of the mouth with much less

* Mr. C. W. Gilmore, who prepared the type specimen of Diceratops, is by no means sure of the "parietal fenestra." There was no bone adhering to the matrix at that point so he left the opening through the frill for want of evidence to the contrary. The bone forming the margin of the left squamosal aperture is decidedly pathologic.

backward extent than in other restorations of Ceratopsia. Here we cannot be guided by the form of the mouth in existing reptiles, for none living have the same feeding habits as these dinosaurs. Here the mouth may properly be divided into an anterior prehensile portion, the turtle-like beak, and a posterior masticating portion, the dental armature. In herbivorous mammals the gape only includes the prehensile and never the masticating portion, because of the necessity of muscular cheeks to retain the food in the mouth. The Ceratopsia had a dental apparatus which chopped the food into short lengths, and the pieces, falling outside of the lower jaw, would have been lost had the gape extended backward beyond the beginning of the tooth series.

Massachusetts Agricultural College, Amherst.

1



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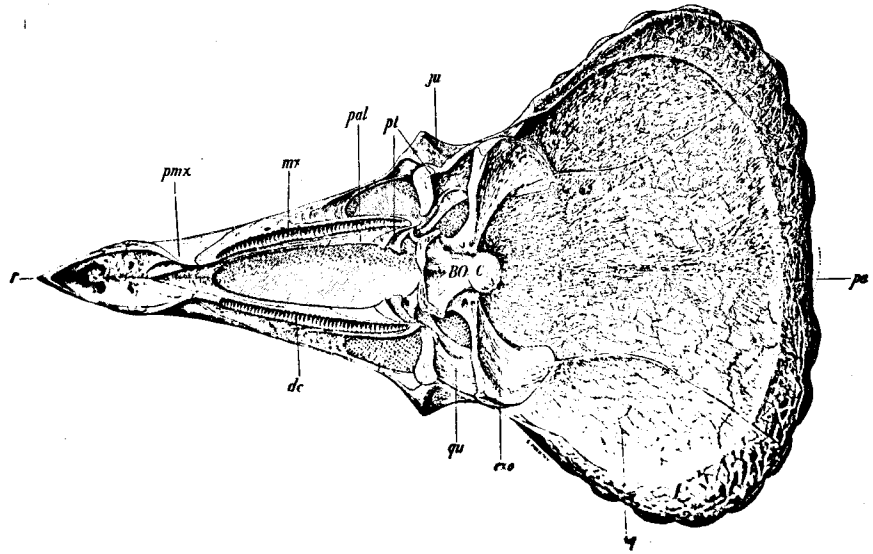
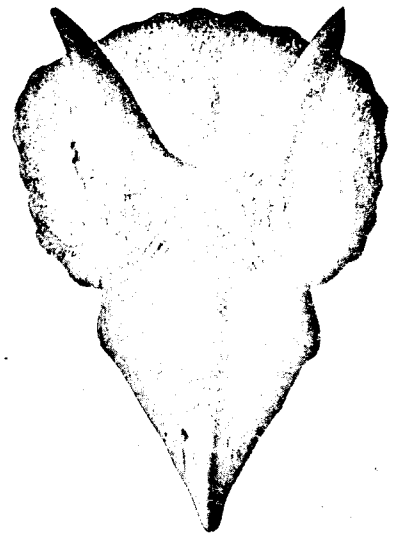


Triceratops [illegible] Hatcher, one-sixteenth natural size.

1



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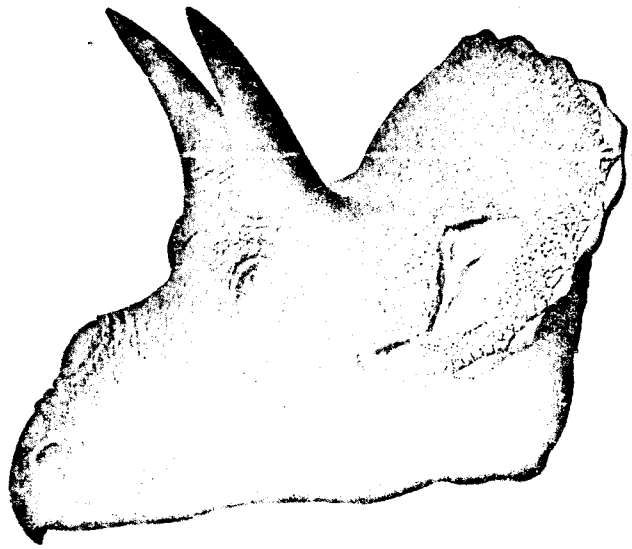
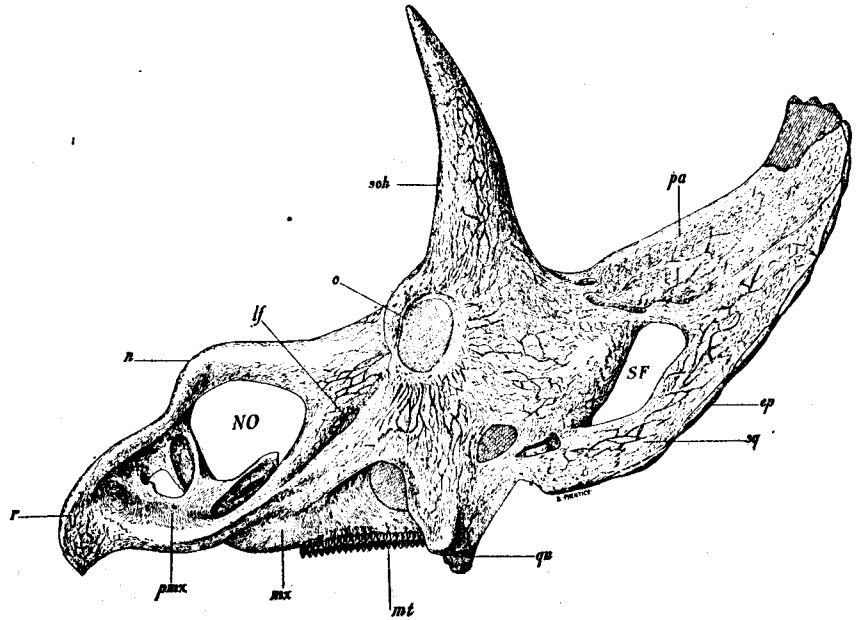


Restoration of *Diceratops hatcheri* Lull, from a model by the author.

The upper figure is that of the front view of the model with the muzzle somewhat depressed.

1



2